Q: An RCC beam 250 × 430 mm overall depth is subj to factored shearforce 45 kN, at support. Check for shear. Design shear reinforcement if necessary. Use M20 concrete & fe415. The beam is provided with tension steel of 684 mm² at effective cover of 50 mm.

Ans:

$V_u = 45$ kN

$D = 430$ mm

$d = 430 - 50 = 380$ mm

$b = 250$ mm

Nominal shear stress $\tau_v = \frac{V_u}{bd} = \frac{45 \times 10^3}{250 \times 380}$

$= 0.474$ N/mm²

finding τ_{cmax}, for M20 concrete,

$\tau_{cmax} = 2.8$ N/mm²

Since $\tau_v < \tau_{c,max} \Rightarrow$ Safe in shear

finding τ_c, $A_{st} = 684$ mm²

$100\frac{A_{st}}{bd} = \frac{100 \times 684}{380 \times 250} = 0.72\%$ ✓

for 0.50% → $\tau_c = 0.48$ N/mm²

for 0.75% → $\tau_c = 0.56$ N/mm²

for 0.72% → $\tau_c = 0.48 + \frac{(0.56-0.48)(0.72-0.5)}{(0.75-0.50)}$

$= 0.55$ N/mm²

$\Rightarrow \tau_v < \tau_c$ $\rightarrow \tau_v < 0.5\tau_c$

$\rightarrow \tau_v > 0.5\tau_c$

$0.5\tau_c = 0.5 \times 0.55 = 0.275\ N/mm^2$

$\tau_v = 0.474\ N/mm^2$

$\Rightarrow \tau_v > 0.5\tau_c \Rightarrow$ Provide minimum shear reinforcement

from Pg 48,

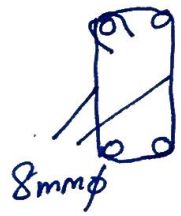
$$\frac{A_{sv}}{b s_v} \geq \frac{0.4}{0.87 f_y} \quad \text{eq 1}$$

Assume 2 legged vertical stirrups of 8mmϕ

$A_{sv} = 2 \pi/4 \times 8^2 = 100.53\ mm^2$

$b = 250\ mm$

$f_y = 415\ N/mm^2$



Subst in eq 1

$$\Rightarrow \frac{100.53}{250 \times s_v} \geq \frac{0.4}{0.87 \times 415}$$

$$\Rightarrow s_v \leq \frac{100.53 \times 0.87 \times 415}{250 \times 0.4}$$

$$\leq 362.96\ mm$$

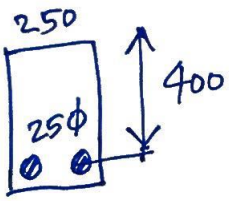
Check whether $s_v \leq$ { $0.75d = 0.75 \times 380 = 285\ mm$ or $300\ mm$

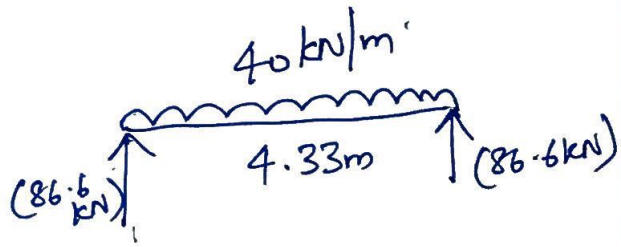
Provide 8mmϕ 2-legged vertical stirrups @ 250 mm c/c

Q: A reinforced concrete beam 250 x 400 mm effective depth and 4.33 m effective span is subjected to 40 kN/m UDL throughout the span. The beam is reinforced with two bars of 25 mm ϕ on tension side. Check for shear and design for shear reinforcement if required. Use M20 concrete & fe 415 steel.

Ans:

Assume the beam is simply supported.





Support reaction $= \frac{40 \times 4.33}{2} = 86.60\ kN$

Shear force at support $= 86.60\ kN$

factored shearforce $V_u = 1.5 \times 86.60$

$= 130\ kN$

Nominal shear stress $\tau_v = \frac{V_u}{bd} = \frac{130 \times 10^3}{250 \times 400}$

$= 1.3\ N/mm^2$

For M20 concrete,

$\tau_{cmax} = 2.8\ N/mm^2$

Since $\tau_v < \tau_{cmax} \Rightarrow$ Safe in shear

To find τ_c,

$$100\frac{A_{st}}{bd} = 100 \times \frac{2\pi/4 \times 25^2}{250 \times 400} = 0.98\% \sim 1\%$$

$$\Rightarrow \tau_c = 0.62 \text{ N/mm}^2$$

$$\tau_v = 1.3 \text{ N/mm}^2$$

Since $\tau_v > \tau_c \Rightarrow$ Provide shear reinforcement

Design of shear reinforcement:

Shear to be resisted by stirrups $V_{us} = V_u - \tau_c bd$

$$= (130 \times 10^3) - (0.62 \times 250 \times 400)$$

$$= 68000 \text{ N}$$

Providing vertical stirrups,

$$\therefore V_{us} = \frac{0.87 f_y A_{sv} d}{S_v}$$

$V_{us} = 68000$ N
$f_y = 415$ N/mm^2
$d = 400$ mm
Assume 2-legged vertical stirrups of 8mm ϕ
$A_{sv} = 2\pi/4 \times 8^2$

$$68000 = \frac{0.87 \times 415 \times 2\pi/4 \times 8^2 \times 400}{S_v}$$

$$\Rightarrow S_v = 211 \text{ mm}$$

Check for spacing $S_v \leq$ { $0.75d = 0.75 \times 400 = 300$mm or 300 mm

Provide 8mm ϕ two legged vertical stirrups @ 200 mm c/c